

Hybrid Chemical-Electric Propulsion (HCEP)

Phase I STTR

Principal Investigator: Christopher Davis, PhD
ElectroDynamic Applications, Inc.
Ann Arbor, Michigan

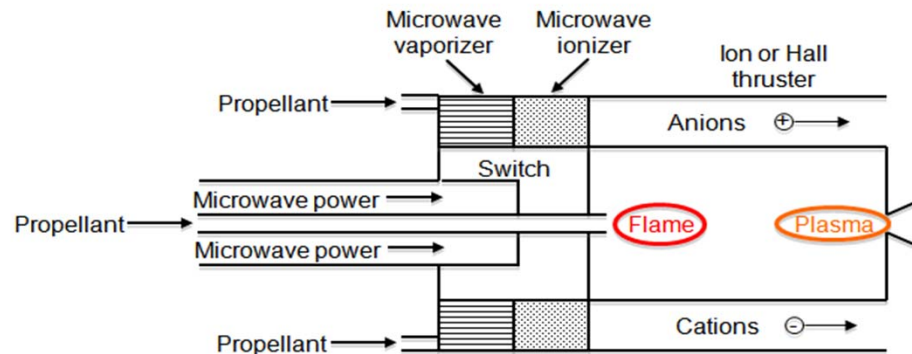
University Principal Investigator: Professor Michael Micci
Penn State University

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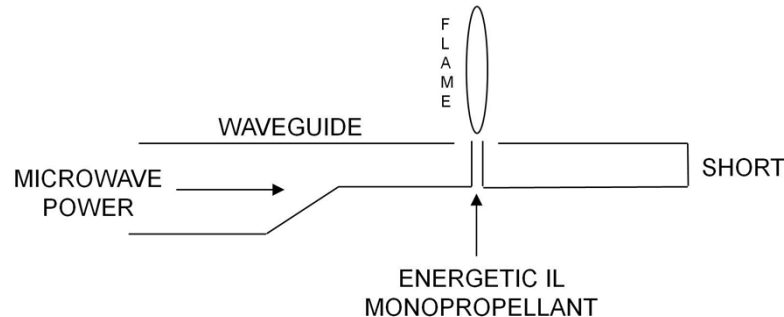
HCEP Thruster Concept

- Can be operated as a chemical thruster and a low or high I_{sp} electric thruster using same ionic liquid (IL) propellant
 - *Chemical, high thrust mode* – Ignite and bring to complete combustion using microwaves in central chamber
 - *Low electric I_{sp} mode* – Electrothermal heating of combustion products to \sim double I_{sp} (<1000 s)
 - Estimated 3-N thrust with 25 kW, 50% thruster efficiency
 - *High electric I_{sp} mode* – microwave energy used to ionize IL propellant; ions then accelerated electrostatically
 - Estimated I_{sp} of ~ 3000 s

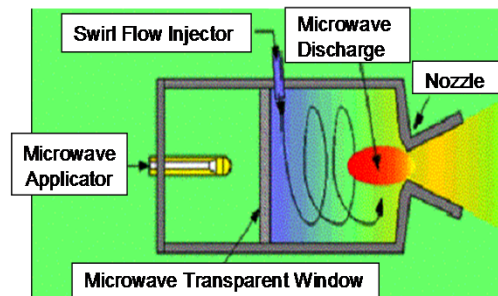


Phase I Tasks (1 of 2)

- Characterization of IL (ionic liquid) ignition and sustainability
 - Measure microwave ignition as a function of flow rate and power
 - Testing performed at PSU facilities using available AF-315E

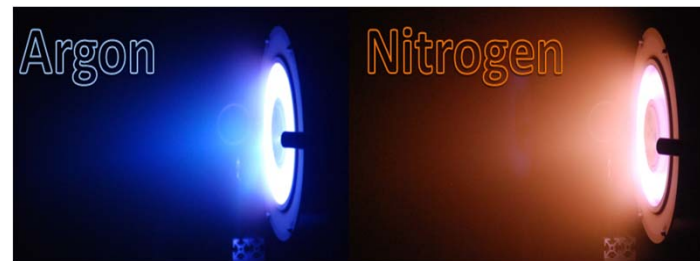
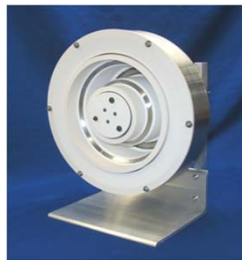


- Demonstration of microwave electrothermal heating of representative combustion products
 - Characterization of mixtures of CO_2 , H_2O , N_2 , N_2O , etc.



Phase 1 Tasks (2 of 2)

- Validation of electrostatic acceleration of simulated ionic liquid components
 - Run well-characterized Hall thruster using representative IL components (CO_2 , N_2O , H_2O , and N_2)
 - Compare results to Xenon performance
 - Testing performed at University of Michigan's Plasmadynamics and Electric Propulsion Laboratory (PEPL) Large Vacuum Test Facility (LVTF)



- Development of conceptual design of a HCEP thruster
 - Electrostatic acceleration design
 - Neutralizer design and integration
 - Method for switching of microwave power between igniter or ionizer
 - Thruster design to operate in 30 kW power range

